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INTERIM REPORT
November 12, 1992

FOR

BIOVENTING FIELD INITIATIVE

AT

ROBINS AIR FORCE BASE, GEORGIA

to

Captain Catherine M. Vogel
Department of the Air Force
Building 1117
HQ AFESC/RDVW
Tyndall AFB, Florida 32403-6001

by

BATTELLE
Columbus Operations
505 King Avenue
Columbus, Ohio 43201-2693

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INTERIM REPORT

BIOVENTING FIELD INITIATIVE AT ROBINS AIR FORCE BASE, GEORGIA

1.0 INTRODUCTION

This report describes the activities conducted at Robins Air Force Base (AFB), Georgia, as part of the Bioventing Field Initiative for the U.S. Air Force Center for Environmental Excellence (AFCEE). This report summarizes the results from the first phase of the study at Robins AFB which includes a soil gas survey, air permeability test, in situ respiration tests, and installation of bioventing systems. The specific objectives of this task are described in the following section.

1.1 Objectives

The purpose of these field test methods is to measure the soil gas permeability and microbial activity at a contaminated site and to evaluate the potential application of the bioventing technology to remediate the site. The specific test objectives are stated below.

- A small-scale soil gas survey will be conducted to identify an appropriate location for installation of the bioventing system. Soil gas from the candidate site should exhibit high total petroleum hydrocarbon (TPH) concentrations, relatively low oxygen concentrations, and relatively high carbon dioxide concentrations. An uncontaminated background location will also be identified.

- The soil gas permeability of the soil and the air vent (well) radius of influence will be determined. This will require air to be withdrawn or injected for approximately 8 hours at vent wells located in contaminated soils. Pressure changes will be monitored in an array of monitoring points.

- Immediately following the soil gas permeability test, an in situ respiration test will be conducted. Air will be injected into selected monitoring points to aerate the soils. The in situ oxygen utilization and carbon dioxide production rates will be measured.

- Using the data from the soil gas permeability and in situ respiration tests, an air injection/withdrawal rate will be determined for use in the bioventing test. A blower will be selected, installed, and operated for 6 to 12 months, and periodic measurements of the soil gas composition will be made to evaluate the long-term effectiveness of bioventing.

1.2 Site Description

Robins AFB is located approximately 10 miles south of Macon, Georgia, adjacent to the town of Warner Robins, Georgia. Site SS10 is located adjacent to a JP-4 jet fuel storage tank farm. Unlike Site UST 173, groundwater is present on this site at depths ranging from 5 to 19 feet. Free product has been encountered floating on the shallow groundwater, and elevated petroleum hydrocarbon concentrations have been detected in site soils. Figure 1 is a schematic diagram of Site SS10.

2.0 CHRONOLOGY OF EVENTS AND SITE ACTIVITIES

2.1 Soil Gas Survey

A limited soil gas survey was conducted to locate a suitable test area at Site SS10 on September 1, 1992. Soil gases were sampled by driving a ⅝-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH. Measurements of oxygen, carbon dioxide, and TPH in the soil gas were made as described in Section 2.1.1.

The soil gas probes were driven to depths ranging from 2.5 to 7.5 feet at several locations at Site SS10. Table 1 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at Site SS10. Oxygen concentrations varied from 0 to 20.5%, whereas TPH concentrations ranged from 4 to greater than 20,000 ppm. These results indicate that, although not all areas of the site are oxygen-limited, some areas may respond to bioventing.

2.2 Vent Well and Monitoring Point Installation

On September 1, 1992, the vent well and three monitoring points were installed, and collection of soil samples for analyses was begun. Groundwater was encountered at 10 feet. The monitoring points were labelled R2-MPA, R2-MPB, and R2-MPC. The location of the vent well and monitoring points is shown in Figure 1. A cross-section of the vent well and monitoring points is shown in Figure 2.

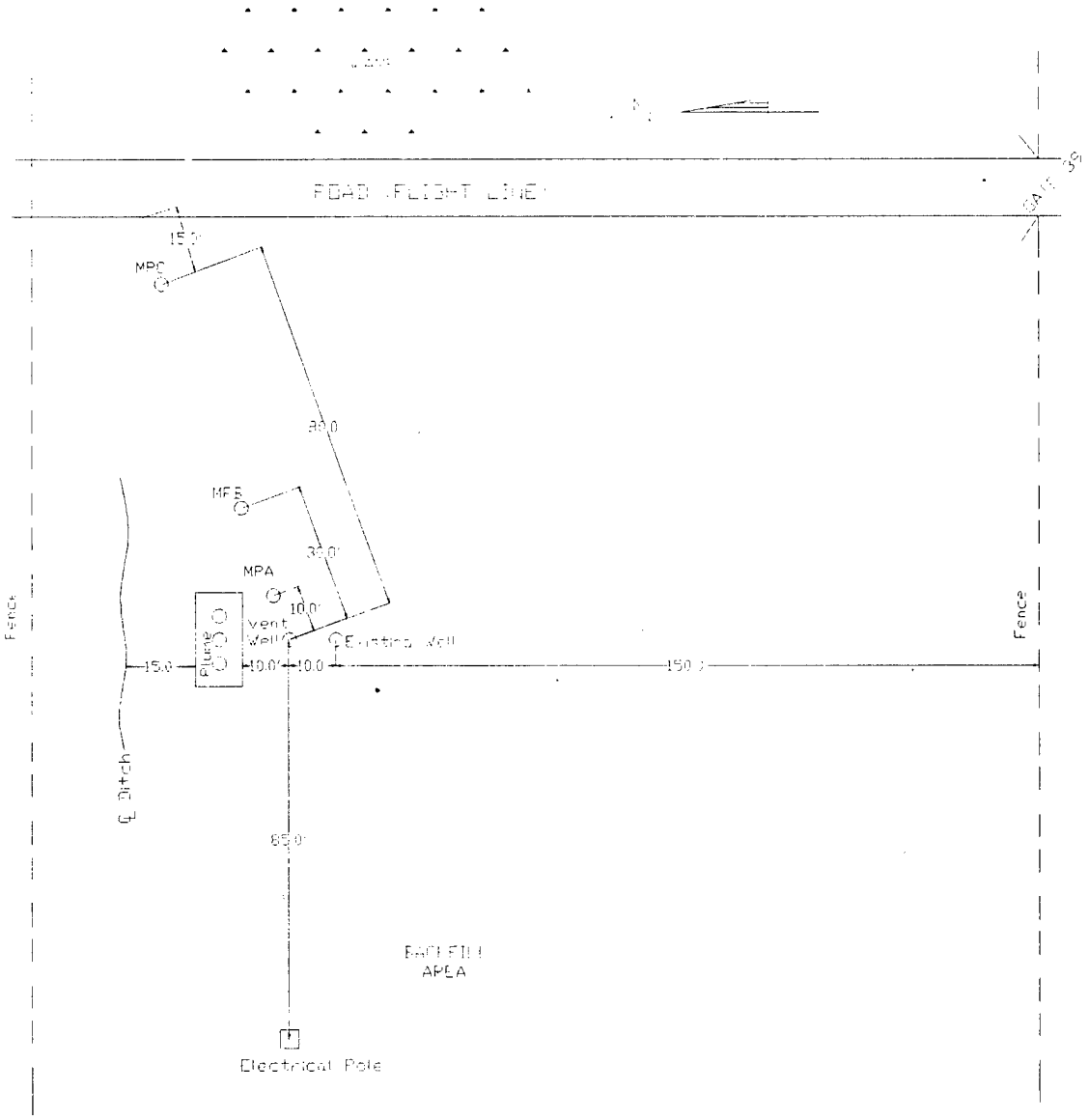

Figure 1. Schematic Diagram of Site SS10 at Robins AFB

Table 1. Initial Soil Gas Composition at Site SS10				
Soil Gas Survey (GS) Point	**Depth (ft)**	**Oxygen (%)**	**Carbon Dioxide (%)**	**TPH (ppm)**
GS-1	2.5	20[1]	0.1	4
	5	0	25	>20,000
GS-2	2.5	5.0[1]	6.5	280
	5	20.5[1]	0.5	230
	7.5	20[1]	0.6	620
GS-3	2.5	15.8[1]	5.8	>10,000
	5	3.0[1]	20	>10,000
GS-5	5	0	>25	>20,000
GS-6	2.5	1.5	>25	>10,000

[1] High pressure reading on vacuum pump. Measurements may be unreliable.

Figure 2. Cross-Section of Vent Well and Monitoring Points Location at Site SS10

The vent well was installed at a depth of 7′3″ into a 6-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch diameter polyvinyl chloride (PVC) piping with 5 feet of ten-slot screen from 2 feet to 7 feet. The annular space corresponding to the screened area of the well was filled with silica sand; the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface. A schematic diagram of the vent well construction is shown in Figure 3.

Soil gas probes consisted of ¼-inch tubing with a 3-inch screened area ¾-inch in diameter. The annular space corresponding to the screened area was filled with silica sand. The interval between the screened areas was filled with bentonite, as was the annular space from the shallowest monitoring point to the ground surface. The monitoring points were installed at depths as follows:

- Monitoring point R2-MPA was installed at a depth of 7′6″ into a 6-inch-diameter borehole. The monitoring point was screened to three depths: 6′, 4′6″, and 3′.
- Monitoring point R2-MPB was installed at a depth of 7′5″ into a 6-inch-diameter borehole. The monitoring point was screened to three depths: 6′, 4′6″, and 3′.
- Monitoring point R2-MPC was installed at a depth of 8′ into a 6-inch-diameter borehole. The monitoring point was screened to three depths: 6′, 4′6″, and 3′.

A schematic diagram of the construction detail of a typical monitoring point for this site is shown in Figure 4.

2.3 Soil and Soil Gas Sampling and Analyses

A soil boring sample was collected at a depth of 7′3″ from the Site SS10 vent well borehole and was labelled R2-V-7′3″. The sample was sent under chain of custody to Engineering-Science Berkeley Laboratory for analysis of BTEX, TPH, iron, and soil chemistry. Soil samples also were taken from monitoring point R1-MPA at depths of 3.0 feet and 4.5 feet and were labelled R2-MPA-3.0′-4.0′ and R2-MPA-4.5′-5.0′. Soil gas samples were also collected from the vent well and from monitoring points R2-MPA-5′ and R2-MPC-8′, and a sample of ambient air was taken. These samples were labelled R2-VW, R2-MPA-5′, R2-MPC-8′, and ambient. These samples were sent under chain of custody to Air Toxics, Ltd. in Rancho Cordova, California, for analysis of BTEX and TPH.

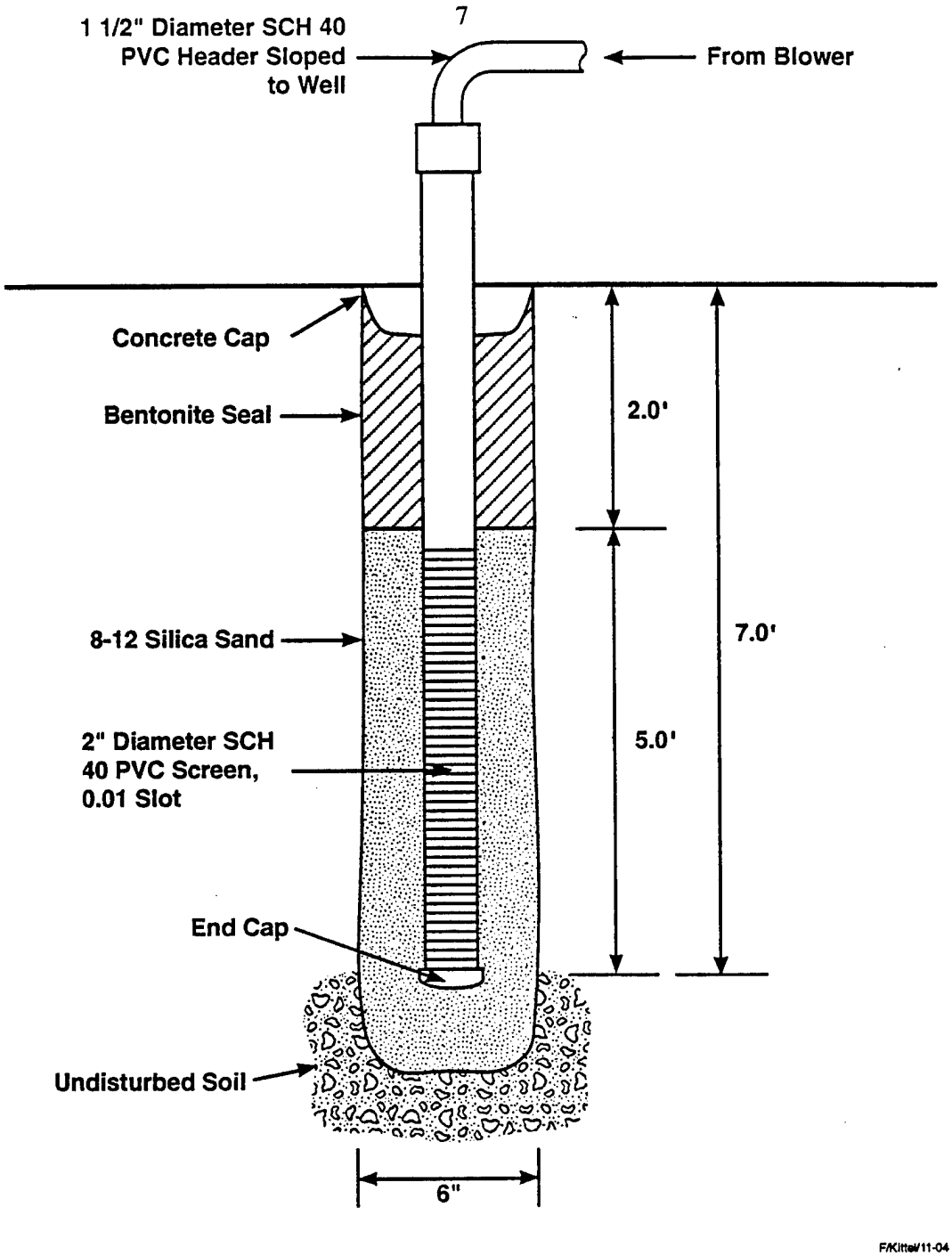

Figure 3. Schematic Diagram of the Vent Well Construction at Site SS10

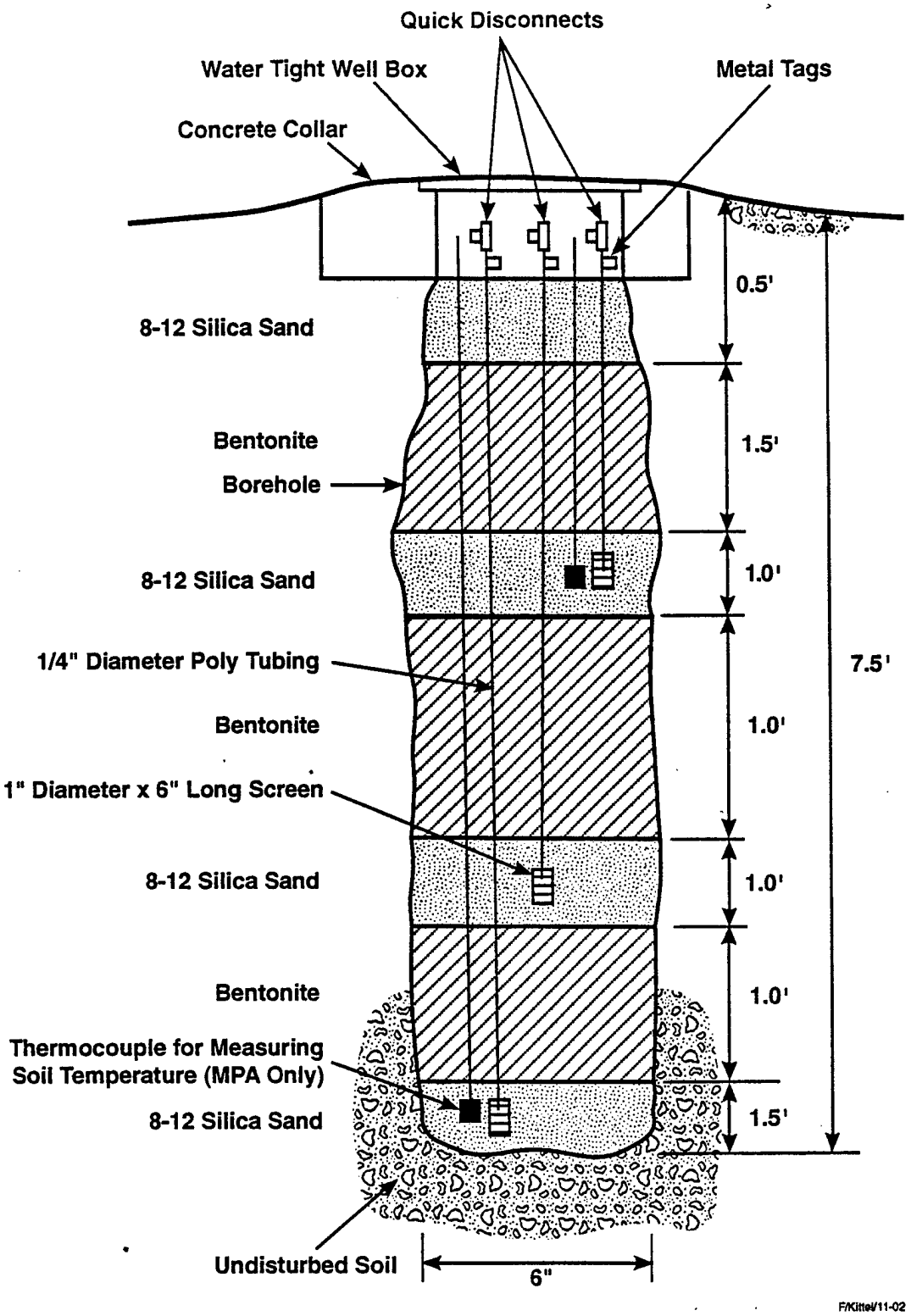

Figure 4. Schematic Diagram of a Typical Monitoring Point Construction at Site SS10

2.4 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute k, the soil gas permeability, is presented in "Test Plan and Technical Protocol for a Field Treatability Test for Bioventing" (Hinchee et al., 1992).

The monitoring points at Site SS10 were allowed to set in place for 24 hours prior to air injection. A portable 2.5-HP explosion-proof positive displacement blower unit was used to inject air. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The Hyperventilate™ computer model was used to calculate the soil gas permeability.

2.5 In Situ Respiration Test

Immediately following the soil gas permeability test at Site SS10, air containing approximately 1% helium was injected into the soil for approximately 24 hours beginning on September 4. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test was as described in "Test Plan and Technical Protocol for a Field Treatability Test for Bioventing" (Hinchee et al., 1992). The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through monitoring points R2-MPA-6′, R2-MPC-6′, R2-MPC-4.5′, and R2-MPA-4.5′ at the depths indicated by the labels. After the air/helium injection was turned off, the respiration gases were monitored periodically. The respiration test was terminated on September 9.

3.0 RESULTS AND DISCUSSION

3.1 Soil and Soil Gas Analyses

In general, water-saturated conditions at Site SS10 were encountered at a depth of approximately 10 feet. Results of the soil analyses for BTEX and TPH are presented in Table 2. Relatively high concentrations of toluene, xylenes, and ethylbenzene were found in soil samples from the vent well, with concentrations ranging from 39 to 220 mg/kg. Lower concentrations were found

Table 2. Results From Soil and Soil Gas Analyses for BTEX and TPH at Site SS10						
Matrix	**Sample Name**	**Benzene (mg/kg)**	**Toluene (mg/kg)**	**Total Xylenes (mg/kg)**	**Ethyl Benzene (mg/kg)**	**TPH[1] (mg/kg)**
Soil	R2-V-7'3"	<1.3	59	220	39	9,000
	R2-A-3'-3'6"	0.053	0.098	0.54	0.054	150
	R2-A-5'-5'6"	<0.26	0.70	6.8	2.0	58
Matrix	**Sample Name**	**Benzene (ppm)**	**Toluene (ppm)**	**Total Xylenes (ppm)**	**Ethyl Benzene (ppm)**	**TPH[1] (ppm)**
Soil Gas	R2-VW	260	120	81	11	42,000
	R2-MPA-5'	220	87	72	14	50,000
	R2-MPC-8'	330	120	100	22	72,000
	Ambient Air[2]	<0.002	<0.002	<0.002	<0.002	0.55

[1] TPH referenced to gasoline (Molecular Weight = 100)
[2] Sample taken at Site SS10 between vent well and R2-MPA.

at monitoring point A (0.098 to 6.8 mg/kg), and benzene was detected only in sample R2-A-3'-3'6". TPH concentrations were highest in the soil sample from the vent well (9,000 mg/kg), while concentrations of 58 and 150 mg/kg were detected in the soil samples from monitoring point A. The soil gas analyses also showed high BTEX and TPH concentrations, with concentrations ranging from 11 to 330 ppm of BTEX, with benzene at the highest concentration, and from 42,000 to 72,000 ppm of TPH (Table 2). The results from the soil chemistry analyses are summarized in Table 3. The laboratory report for the BTEX, TPH, and the soil chemistry analysis is given in Appendix A.

3.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at Site SS10 are presented in Appendix B. Using the Hyperventilate™ computer model, soil gas permeabilities were calculated at each of the monitoring points. These data appear in Table 4. The soil gas permeability varied considerably between points with values ranging from 1.5 up to 1.01 x E9 darcy. The radius of influence for the vent well was calculated by plotting the log of the pressure at a specific monitoring versus the distance from the vent well (Figure 5). The radius of influence at Site SS10 is estimated to be approximately 75 feet.

3.3 In Situ Respiration Test

The results of the in situ respiration test for Site SS10 are presented in Appendix C. Each figure in Appendix C illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization and carbon dioxide production at this site is shown in Figure 6, which shows oxygen, carbon dioxide, and helium at monitoring point R2-MPC-6'. These results are typical for oxygen utilization and carbon dioxide production at monitoring point R2-MPC, while the rates were somewhat slower at monitoring point R2-MPA. The oxygen utilization and carbon dioxide production rates and corresponding biodegradation rates are summarized in Table 5. The biodegradation rates measured at this site ranged from 1.2 to 6.4 mg/kg/day based upon oxygen and from 0.19 to 0.57 mg/kg/day for carbon dioxide. Biodegradation rates based upon carbon dioxide production were consistently lower than those calculated based upon oxygen utilization, suggesting that carbon dioxide was reacting chemically in the soil.

Table 3. Results From Soil Chemistry Analyses at Site SS10			
Parameter	Sample Name		
	R2-V-7'3"	R2-A-5'-5'6"	R2-A-3'-3'6"
Alkalinity (mg/kg $CaCO_3$)	<50	<50	<50
Moisture (% by weight)	8.2	11.8	9.8
pH	5.2	5.0	5.8
Iron (mg/kg)	1,780	4,070	4,960
Total Phosphorous (mg/kg)	43	81	110
Total Kjeldahl Nitrogen (mg/kg)	37	31	70
Particle Size Analysis	Gravel: 0%	Gravel: 0%	Gravel: 4%
	Sand: 61%	Sand: 49%	Sand: 57%
	Silt: 25%	Silt: 25%	Silt: 19%
	Clay: 14%	Clay: 26%	Clay: 20%

Table 4. Results of Hyperventilate™ Soil Gas Permeability Analysis		
Monitoring Point	Depth	Soil Gas Permeability (darcy)
R2-MPA	3'	1.01 x E9
	4'6"	5.3 x E8
	6'	9.9 x E9
R2-MPB	3'	2.4 x E6
	4'6"	4.3 x E5
	6'	8.1 x E5
R2-MPC	3'	1.5
	4'6"	340
	6'	670

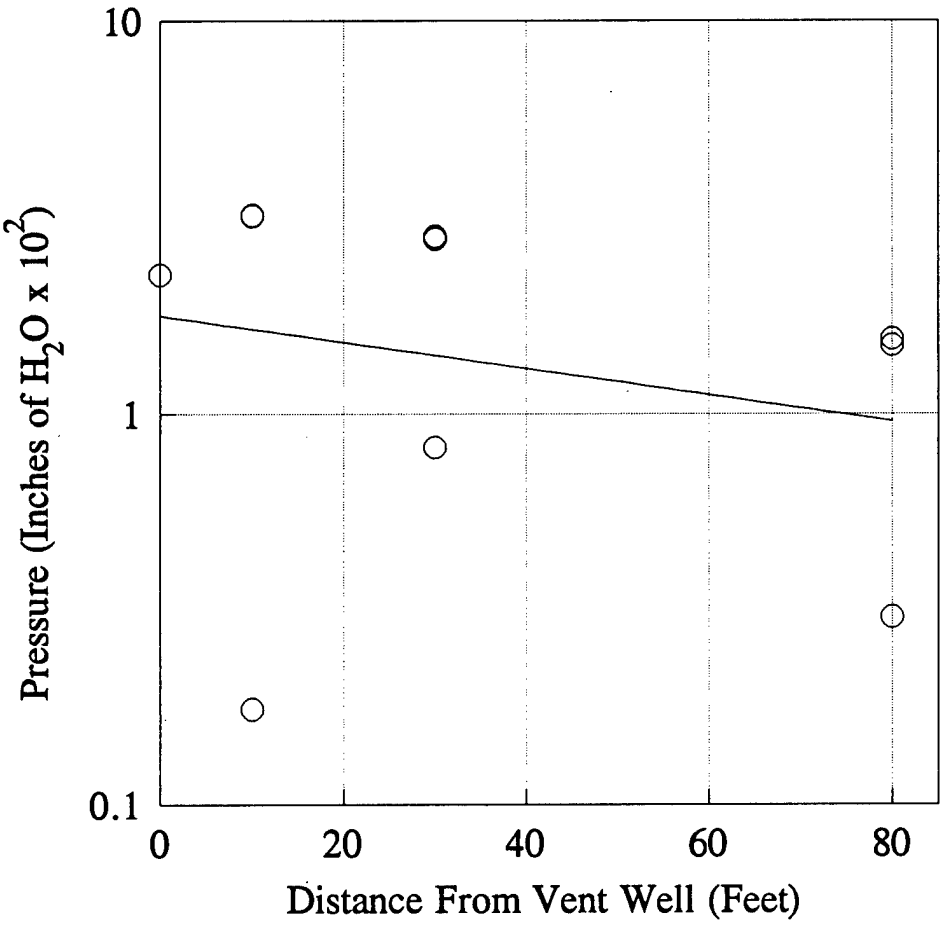

Figure 5. Calculation of Radius of Influence at Site SS10

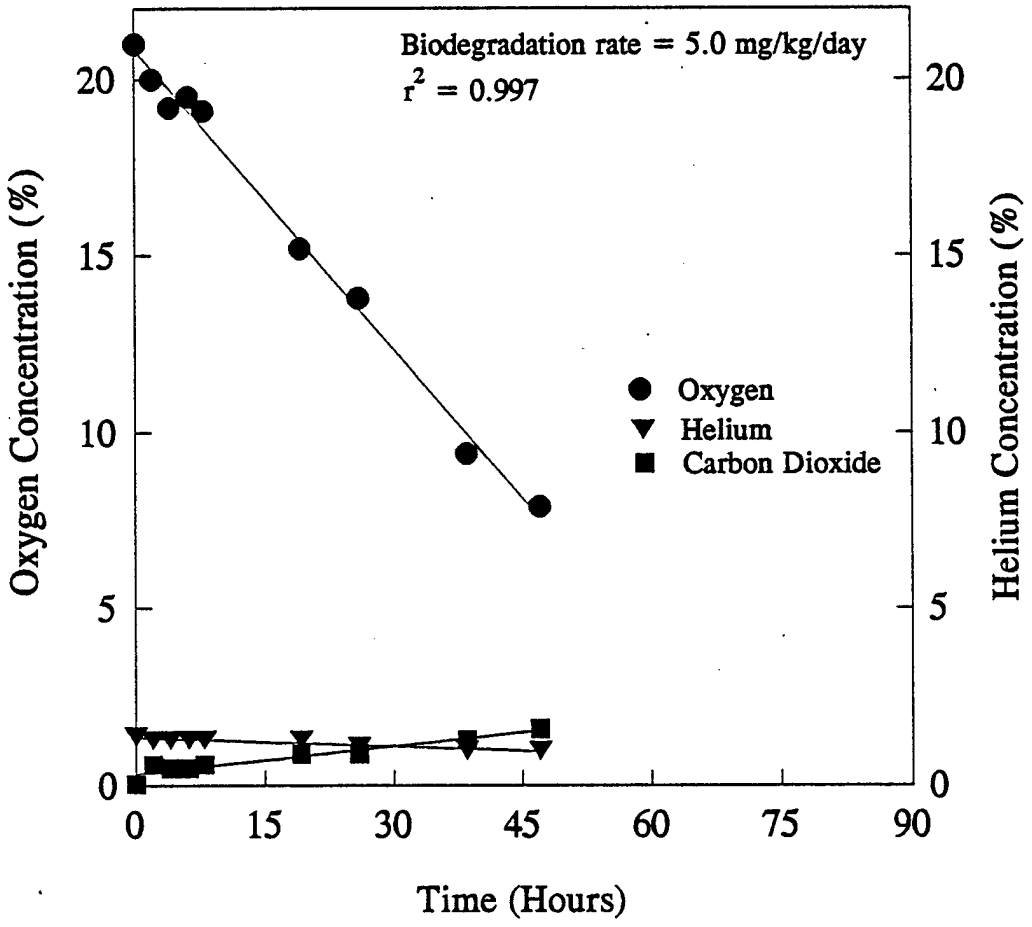

Figure 6. Oxygen Utilization During In Situ Respiration Test at Monitoring Point R2-MPC-6'

Table 5. Oxygen Utilization Rates During In Situ Respiration Test at Site SS10				
Sample Name	**Oxygen Utilization Rate (%/hour)**	**Biodegradation Rate (mg/kg/day)**	**Carbon Dioxide Utilization Rate (%/hour)**	**Biodegradation Rate (mg/kg/day)**
Background	0	0	0	0
R2-MPA-4′6″	0.061	1.2	0.0086	0.19
R2-MPA-6′	0.074	1.4	0.0095	0.20
R2-MPC-4′6″	0.34	6.4	0.024	0.51
R2-MPC-6′	0.26	5.0	0.026	0.57

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well-sealed and that the oxygen depletion observed was a result of biodegradation.

3.4 Bioventing Demonstration

The decision was made to install a bioventing system at Site SS10. The same blower that was used for the soil gas permeability test was installed for the bioventing system. Continuous air injection was initiated on September 10 at a flow rate of 27 cubic feet per minute (cfm).

4.0 BACKGROUND AREA

The background location used for this site was the same as the one described in the Interim Report for Site UST 173. The background vent well was installed on August 31, 1992. The depth of this vent well was 23 feet. Ten feet were screened using Schedule 40, 2-inch-diameter, 10 slot PVC, and the remaining 13 feet consisted of Schedule 40, 2-inch-diameter PVC riser. The first 15 feet of the vent well was surrounded by sand, while 6 of the remaining 8 feet was enclosed by bentonite to seal the vent well. A schematic diagram of the vent well construction is shown in Figure 7.

An in situ respiration test was conducted at the background area beginning on September 5 after 24 hours of air injection. The test was concluded on September 9. No significant biodegradation was detected in this area as shown in Figure 8.

5.0 FUTURE WORK

Base personnel will be required to perform a simple weekly system check to ensure that the blower is operating within its intended flow rate, pressure, and temperature range. This check must be coordinated with the base Point-of-Contact (POC). An on-site briefing for base personnel who will be responsible for blower system checks was conducted. The principle of operation was explained, and a simple checklist and logbook were provided for blower data. Base personnel will perform minor maintenance activities, such as replacing filters or gauges, or draining condensate from

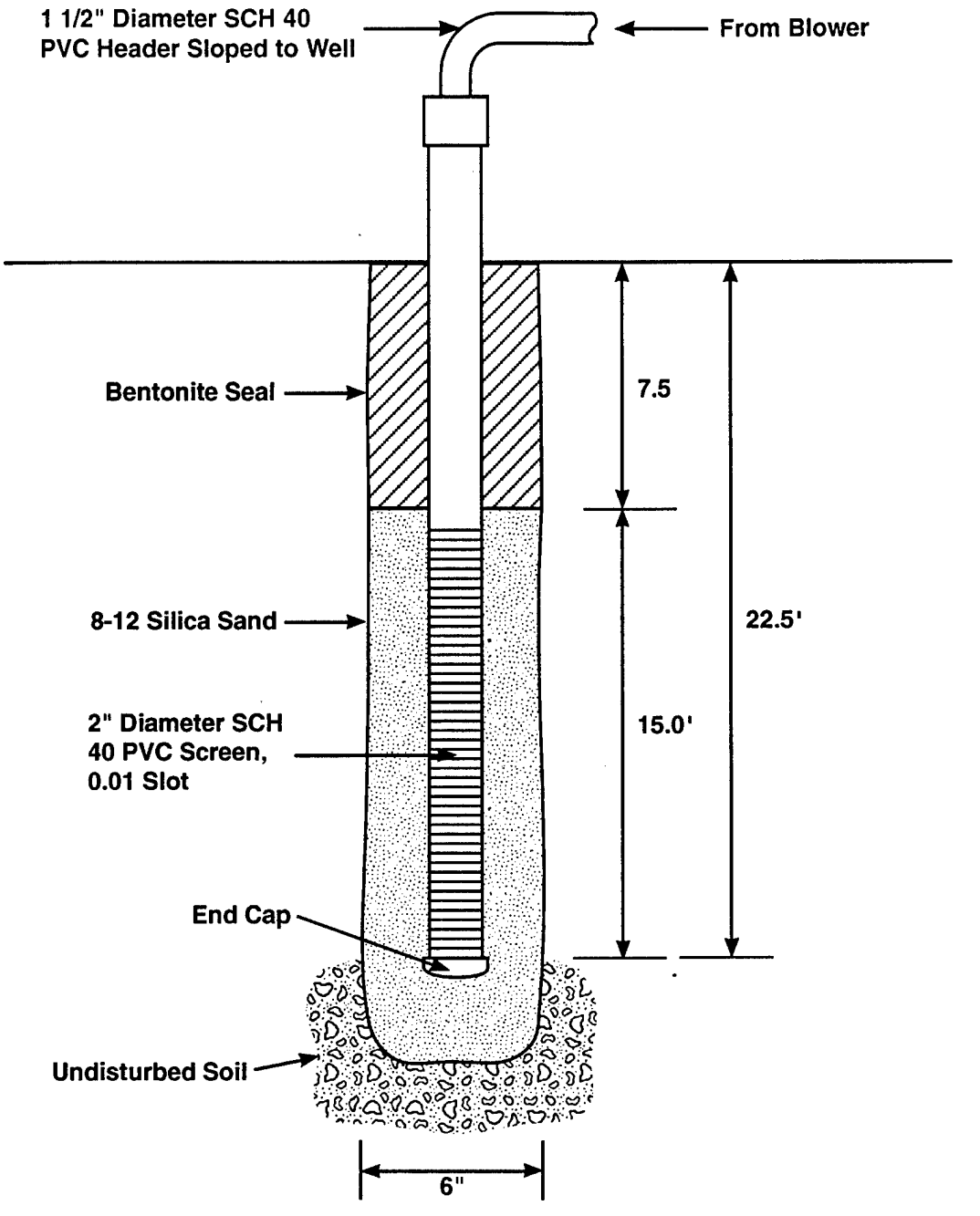

Figure 7. Schematic Diagram of Vent Well Construction at the Background Area

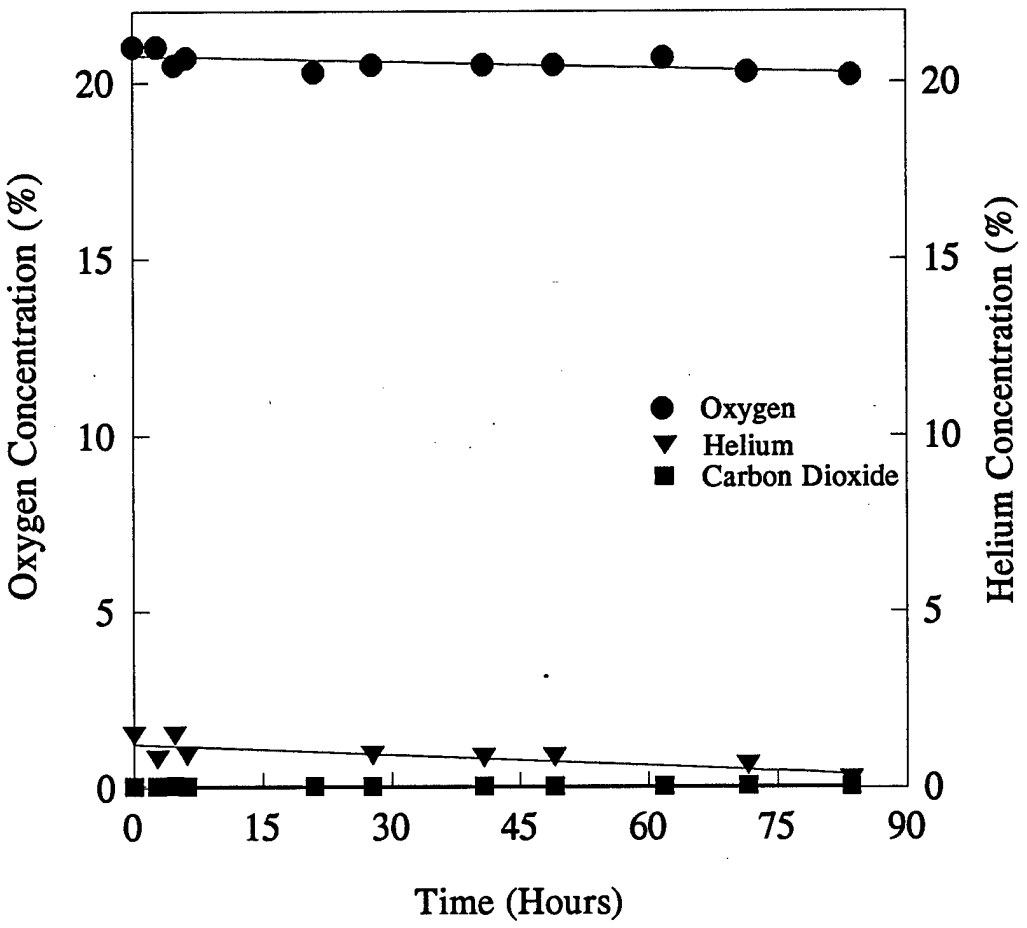

Figure 8. Oxygen Utilization During In Situ Respiration Test at Background Area

knockout chambers, but they will not be expected to perform complicated repairs or analyze gas samples. Replacement filters and gauges will be provided and shipped to the base by the contractor. Serious problems such as motor or blower failures will be corrected by the contractor.

The progress of this system will be monitored by conducting semiannual respiration tests in the vent well and in each monitoring point, and by regularly measuring the oxygen, carbon dioxide, and hydrocarbon concentrations in the extracted soil gas and comparing them to background levels. Soil gas monitoring will be performed on a quarterly basis. Semiannual respiration tests will be performed. At least twice each year, the progress of the bioventing test will be reported to the base POC.

6.0 REFERENCE

Hinchee, R.E., S.K.Ong, R.N.Miller, D.C.Downey, and R.Frandt. 1992. "Test Plan and Technical Protocol for a Field Treatability Test for Bioventing," Revision 2.

APPENDIX A

ANALYTICAL REPORT FOR SITE SS10

BERKELEY LABORATORY
600 BANCROFT WAY
BERKELEY, CA 94710
Tel: (415) 841-7353

ENGINEERING-SCIENCE, INC.

Report Date: October 15, 1992

Work Order No.:4310

Client: Jeff Kittel
Battelle
505 King Ave
Columbus, OH 43201

Date of Sample Receipt: 09/04/92

Your soil samples identified as:

R2-V-7'-3"
R2-A-5-5.5'
R2-A-3-3.5'

were analyzed for BTEX by EPA Method 8020, pH, alkalinity, iron, total kjeldahl nitrogen, soil moisture, TRPH by EPA Method 418.1, soil classification by ASTM D422 and total phosphorus.

The analytical reports for the samples listed above are attached.

CL-FORM

GC VOLATILES DATA PACKAGE

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4310 % Moisture: 8.18

Client ID:R2-V-7'3" Matrix:SOIL

Laboratory ID:4310-1 Level:MEDIUM

Unit:ug/KG

Dilution Factor: 20 Date Analyzed:09/09/92
Date Confirmed:09/14/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	1300.0
Ethyl Benzene	24000.0	39000.0	1100.0
Toluene	68000.0	59000.0	1500.0
Xylenes (total)	170000.0	220000.0	2000.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4310 % Moisture: 8.18

Client ID:R2-A-5-5.5' Matrix:SOIL

Laboratory ID:4310-2 Level:MEDIUM

Unit:ug/KG

Dilution Factor: 4 Date Analyzed:09/09/92
Date Confirmed:09/14/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	260.0
Ethyl Benzene	480.0	2000.0	220.0
Toluene	870.0	700.0	300.0
Xylenes (total)	3600.0	6800.0	390.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4310 % Moisture: 11.82

Client ID:R2-A-3-3.5' Matrix:SOIL

Laboratory ID:4310-3 Level:LOW

Unit:ug/KG

Dilution Factor: 5 Date Analyzed:09/10/92
Date Confirmed:09/14/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	80.0	53.0	3.4
Ethyl Benzene	83.0	54.0	2.8
Toluene	100.0	98.0	4.0
Xylenes (total)	480.0	540.0	5.1

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER: Russell

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4310 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MSVG3920910 Level:LOW

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:09/10/92

Date Confirmed:

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	0.6
Ethyl Benzene	ND	ND	0.5
Toluene	ND	ND	0.7
Xylenes (total)	ND	ND	0.9

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4310 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MSVG5920914 Level:LOW

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:09/14/92
Date Confirmed:

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	0.6
Ethyl Benzene	ND	ND	0.5
Toluene	ND	ND	0.7
Xylenes (total)	ND	ND	0.9

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4310 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MWVG3920909 Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:09/09/92
Date Confirmed:

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total).	ND	ND	90.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4310 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MWVG2920914 Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:09/14/92
Date Confirmed:

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total)	ND	ND	90.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER:

ES-ENGINEERING SCIENCE,INC.

600 BANCROFT WAY
BERKELEY, CA 94710

GC ANALYTICAL REPORT
ANALYTICAL REPORT
BTEX AROMATIC COMPOUNDS

MATRIX: LOW SOIL COLUMN ID: VGC-3 VOCOL DATE:09/10/92

LABORATORY NO.	CLIENT ID	a-a-a-TriFluoro Toluene
MSVG3920910	METHOD BLANK	111
SSVG3920910A	SPIKE	110
SSVG3920910B	SPIKE DUP	102
4310-3	R2-A-3-3.5'	94

ES-ENGINEERING SCIENCE,INC.
600 BANCROFT WAY
BERKELEY, CA 94710

GC ANALYTICAL REPORT
ANALYTICAL REPORT
BTEX AROMATIC COMPOUNDS

MATRIX: LOW SOIL COLUMN ID: VGC-5 DB624 DATE:09/14/92

LABORATORY NO.	CLIENT ID	a-a-a-TriFluoro Toluene
MSVG5920914	METHOD BLANK	92
SSVG5920914A	SPIKE	91
SSVG5920914B	SPIKE DUP	92
4310-3	R2-A-3-3.5'	144

ES-ENGINEERING SCIENCE,INC.
600 BANCROFT WAY
BERKELEY, CA 94710

GC ANALYTICAL REPORT
ANALYTICAL REPORT
BTEX AROMATIC COMPOUNDS

MATRIX: MEDIUM SOIL COLUMN ID: VGC-3 VOCOL DATE:09/09/92

LABORATORY NO.	CLIENT ID	a-a-a-TriFluoro Toluene
MWVG3920909	METHOD BLANK	78
SWVG3920909A	SPIKE	98
SWVG3920909B	SPIKE DUP	99
4310-1	R2-V-7'3"	71
4310-2	R2-A-5-5.5'	98

ES-ENGINEERING SCIENCE,INC.

600 BANCROFT WAY
BERKELEY, CA 94710

GC ANALYTICAL REPORT
ANALYTICAL REPORT
BTEX AROMATIC COMPOUNDS

MATRIX: MEDIUM SOIL COLUMN ID: VGC-2 DB624 DATE:09/14/92

LABORATORY NO.	CLIENT ID	a-a-a-TriFluoro Toluene
MWVG2920914	METHOD BLANK	98
4310-1	R2-V-7'3"	140
4310-2	R2-A-5-5.5'	118

METHOD BLANK SUMMARY

WO # 4310

LAB NAME : ENGINEERING-SCIENCE, INC. DATE ANALYZED :09/10/92

LAB SAMPLE ID:MSVG3920910 DATE EXTRACTED : NA

MATRIX :SOIL INSTRUMENT ID:VGC-3

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MSVG3920910	METHOD BLANK	09/10/92
SSVG3920910A	SPIKE	09/10/92
SSVG3920910B	SPIKE DUPLICATE	09/10/92
4310-3	R2-A-3-3.5'	09/10/92

METHOD BLANK SUMMARY

WO # 4310

LAB NAME : ENGINEERING-SCIENCE, INC. DATE ANALYZED :09/14/92

LAB SAMPLE ID:MSVG5920914 DATE EXTRACTED : NA

MATRIX :SOIL INSTRUMENT ID:VGC-5

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MSVG5920914	METHOD BLANK	09/14/92
SSVG5920914A	SPIKE	09/14/92
SSVG5920914B	SPIKE DUPLICATE	09/14/92
4310-3	R2-A-3-3.5'	09/14/92

METHOD BLANK SUMMARY

WO # 4310

09 TP 10/15

LAB NAME : ENGINEERING-SCIENCE, INC. DATE ANALYZED :09/~~10~~/92

LAB SAMPLE ID:MWVG3920909 DATE EXTRACTED : NA

MATRIX :MEDIUM SOIL INSTRUMENT ID:VGC-3

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MWVG3920909	METHOD BLANK	09/09/92
SWVG3920909A	SPIKE	09/09/92
SWVG3920909B	SPIKE DUP	09/09/92
4310-1	R2-V-7'3"	09/09/92
4310-2	R2-V-5-5.5'	09/09/92

METHOD BLANK SUMMARY

WO # 4310

LAB NAME : ENGINEERING-SCIENCE, INC. DATE ANALYZED :09/14/92

LAB SAMPLE ID:MWVG2920914 DATE EXTRACTED : NA

MATRIX :MEDIUM SOIL INSTRUMENT ID:VGC-2

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MWVG2920914	METHOD BLANK	09/14/92
4310-1	R2-V-7'-3"	09/14/92
4310-2	R2-A-5-5.5'	09/14/92

TOTAL RECOVERABLE PETROLEUM HYDROCARBONS
DATA PACKAGE

ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way
Berkeley,CA 94710

ORGANIC ANALYTICAL REPORT

Work Order NO.: 4310

Matrix: Soil

Parameter: TPH

Unit: mg/Kg

Analytical Method: 418.1

Date Extracted: 09/22/92

QC Batch NO.: S92QCB023TPH

Date Analyzed: 09/22/92

Sample ID:	Client ID:	Result	Reporting Limit	Percent Moisture
4310-01	R2-V-7'3"	9000	4	8.2
4310-02	R2-A-5-5.5'	58	5	11.8
4310-03	R2-A-3-3.5'	150	4	9.8
MSTPH920922	METHOD BLANK	ND	4	NA

NA_ Not Analyzed
ND_ Not Detected

ANALYST:

GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way
Berkeley. CA 94710

ORGANIC QUALITY CONTROL RESULTS SUMMARY
Blank Spike/Spike Duplicate

Work Order NO.: 4310

QC Sample NO.: SSTPH920915A & B Analytical Method: 418.1

Blank I.D.: MSTPH920915 Matrix: Soil

QC Batch NO.: S92QCB023TPH Unit: mg/Kg

Parameter	Date Analyzed	BR	SA	BS	PR	BSD	PR	RPD
TPH	09/22/92	0	165	176	107	172	104	2

BS-Blank Spike
BSD-Blank Spike Duplicate
SA-Spike Added
BR_Blank Result
NA-Not Applicable
NC-Not Calculated
ND-Not Detected

RPD=((BS-BSD)/((BS+BSD)/2))*100

PR=((BS OR BSD -BR)/SA)*100

ANALYST:

QUALITY CONTROL:

INORGANICS DATA PACKAGE

ES-ENGINEERING-SCIENCE, INC.
600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: AFCEE

Work Order: 4310
Matrix: Solid

Client's ID:	R2-V -7'3"	R2-A -5-5.5'	R2-A -3-3.5'				
Sample Date:	09/01/92	09/01/92	09/01/92				
% Moisture:							
Lab ID:	4310.01	4310.02	4310.03				
Parameter	----------Results----------			Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND	ND	ND	SM 403(M)	50	mg/Kg CaCO3	09/10/92
Moisture	8.2	11.8	9.8	ASTM D2216	.1	% by wt	09/18/92
pH	5.2	5.0	5.8	EPA 9045	NA	pH Units	09/15/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Gleaton

GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: AFCEE

Work Order: 4310
Matrix: Solid

Client's ID: Prep Blank

Sample Date:
% Moisture:
Lab ID: Prep Blank

Parameter	Results	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND	SM 403(M)	50	mg/Kg CaCO3	09/10/92
Moisture	NA	ASTM D2216	.1	% by wt	09/18/92
pH	NA	EPA 9045	NA	pH Units	09/15/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Gleaton

GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANICS QC SUMMARY - LAB CONTROL SAMPLE

Work Order: 4310

% Moisture: NA

Lab ID of LCS:
Alkalinity: 452.22 LCS

Matrix: Solid

Units: mg/Kg CaCO3

Parameter	Date Analyzed LCS	LCS Result	Conc Added	% Rec LCS	Advisory Limits -- % Rec -- Low	High
Alkalinity	09/10/92	23000.00	23650.00	97	80	120

ANALYST: Don Gleator Date 9/28/92 REVIEWER: MVB Date 9/29/92

File:M1QCLCSW

ES-ENGINEERING-SCIENCE, INC.
600 Bancroft Way
Berkeley, CA 94710

INORGANIC QC SUMMARY - MS and MSD

Work Order: 4310

% Moisture: NA

Matrix: Solid

Units: mg/Kg CaCO3 (Alk)
% by wt. (Mois)
pH Units (pH)

	Alkalinity	Moisture	pH
Lab ID Spk/Dup:	Blank Spk	4310.01	4294.01
QC Batch:	452.22	451.52	453.34

Parameter	Date Analyzed MS/Dup	Unspiked Sample	MS/Sample	MSD/Dup	RPD	RPD QC Limit	-Conc Added- MS	MSD	Percent Recovered MS	MSD
Alkalinity	09/10/92	0.00	23000.00	23000.00	0	20	23650.00	23650.00	97	97
Moisture	09/18/92		8.18	8.18	0	20				
pH	09/15/92		5.21	5.49	5	20				

* or N = Outside QC Limit:

QC Limits for % Rec: 75 - 125

ANALYST: Don Gleaton Date 9/28/92 REVIEWER: NWB Date 9/29/92

File:M1QCMSWM

METALS DATA PACKAGE

Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

V-7'3"

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4294S SAS No.: _____ SDG No.: A-3___

Matrix (soil/water): SOIL_ Lab Sample ID: 4310.01___

Level (low/med): LOW__ Date Sampled : 09/01/92

% Solids: _91.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	1780		E	P

Comments:

FORM I - IN

3/90

Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

A-5

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4294S SAS No.: _____ SDG No.: A-3___

Matrix (soil/water): SOIL_ Lab Sample ID: 4310.02___

Level (low/med): LOW__ Date Sampled : 09/01/92

% Solids: _88.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	4070		E	P

Comments:

FORM I - IN

3/90

Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID: A-3

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4294S SAS No.: _____ SDG No.: A-3___

Matrix (soil/water): SOIL_ Lab Sample ID: 4310.03___

Level (low/med): LOW__ Date Sampled : 09/01/92

% Solids: _90.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	4960		E	P

Comments:

FORM I - IN

3/90

Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

PBLANK

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4294S SAS No.: _____ SDG No.: A-3___

Matrix (soil/water): SOIL_ Lab Sample ID: PREP BLANK

Level (low/med): LOW__ Date Sampled : 09/16/92

% Solids: 100.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	4.7	U	E	P

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Engineering Science - Berkeley Laboratory
Inorganic Report

ICP SERIAL DILUTION

EPA SAMPLE NO.

MPA-18L

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4294S_ SAS No.: _____ SDG No.: A-3___

Matrix (soil/water): SOIL_ Level (low/med): LOW__

Concentration Units: ug/L

Analyte	Initial Sample Result (I)	C	Serial Dilution Result (S)	C	% Difference	Q	M
Iron	39532.95		43887.12		11.0	E	P

FORM IX - IN

ILMO2.1

Engineering Science - Berkeley Laboratory

Method Detection Limits (Annually)

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4294S_ SAS No.: _____ SDG No.: A-3___

ICP ID Number: TJA_61_____M Date: 09/01/92

Flame AA ID Number : _____ Matrix: SOIL_

Furnace AA ID Number : _____ (ug/L in 1.00g to 100ml digestate)

Analyte	Wave-length (nm)	Back-ground		MDL (ug/L)	M
Iron	271.44			47.0	P

Comments:

Engineering Science - Berkeley Laboratory
Inorganics Report

PREPARATION LOG

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.:_4294S_ SAS No.: _____ SDG No.:A-3___

Method: P_

EPA Sample No.	Preparation Date	Weight (gram)	Volume (mL)
A-3	09/16/92	1.06	100
A-5	09/16/92	1.01	100
A-8.5'	09/16/92	1.00	100
LCSS	09/16/92	1.00	100
LCSSD	09/16/92	1.00	100
MPA-07	09/16/92	1.06	100
MPA-18	09/16/92	1.02	100
MPA-18S2	09/16/92	1.05	100
MPA-18S1	09/16/92	1.00	100
MPB-06	09/16/92	1.03	100
MPB-18	09/16/92	1.00	100
MPC-06	09/16/92	1.00	100
MPD5'8	09/16/92	1.03	100
PBLANK	09/16/92	1.00	100
V-18'	09/16/92	1.06	100
V-4.0'	09/16/92	1.02	100
V-7'3"	09/16/92	1.02	100
VW-8	09/16/92	1.05	100

Engineering Science - Berkeley Laboratory
Inorganics Report

ANALYSIS RUN LOG

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4294S_ SAS No.: _____ SDG No.:A-3___

Instrument ID Number: TJA 61 M_ Method: P_

Start Date: 09/17/92 End Date: 09/17/92

EPA Sample No.	D/F	Time	% R	Analytes FE
STD1	1.00	1423		X
STD2	1.00	1427		X
STD3	1.00	1432		X
STD4	1.00	1437		X
ICV	1.00	1441		X
ICB	1.00	1446		X
ICSA	1.00	1451		X
ICSAB	1.00	1455		X
CRI	1.00	1500		
PBLANK	1.00	1504		X
ZZZZZZ	1.00	1509		
LCSS	1.00	1514		X
LCSSD	1.00	1518		X
A-8.5'	1.00	1523		X
V-4.0'	1.00	1527		X
V-18'	1.00	1532		X
CCV	1.00	1537		X
CCB	1.00	1541		X
V-7'3"	1.00	1546		X
A-5	1.00	1551		X
A-3	1.00	1555		X
VW-8	1.00	1600		X
MPA-07	1.00	1604		X
MPA-18	1.00	1609		X
MPA-18S1	1.00	1614		X
MPA-18S2	1.00	1618		X
MPA-18L	1.00	1623		X
CCV	1.00	1627		X
CCB	1.00	1632		X
MPB-18	1.00	1637		X
MPB-06	1.00	1641		X
MPC-06	1.00	1646		X

Engineering Science - Berkeley Laboratory
Inorganics Report

ANALYSIS RUN LOG

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

La Code: ESBL__ Case No.: 4294S_ SAS No.: _____ SDG No.:A-3___

Instrument ID Number: TJA 61 M_ Method: P_

Start Date: 09/17/92 End Date: 09/17/92

EPA Sample No.	D/F	Time	% R	Analytes FE
MRD5'8__	1.00	1651		X
ICSA_____	1.00	1655		X
ICSAB____	1.00	1700		X
CRI_____	1.00	1704		
CCV_____	1.00	1709		X
CCB_____	1.00	1714		X

TOTAL KJELDAHL NITROGEN
TOTAL PHOSPHATE
SOIL CLASSIFICATION
DATA PACKAGE

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Sep. TP 9/28/92

Engineering Science, Inc.	Client Project ID:	W.O. #4310	Sampled:	~~Aug~~ 1, 1992
600 Bancroft Way	Sample Descript:	Soil	Received:	Sep 8, 1992
Berkeley, CA 94710	Analysis for:	Total Phosphorous	Analyzed:	Sep 16, 1992
Attention: Tom Paulson	First Sample #:	209-0841	Reported:	Sep 22, 1992

LABORATORY ANALYSIS FOR: Total Phosphorous

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
209-0841	R2-V-7'-3"	10	43
209-0842	R2-A-5'-5.5'	10	81
209-0843	R2-A-3'-3.5'	10	110
-	Method Blank	10	N.D.

THIS REPORT HAS BEEN APPROVED AND REVIEWED BY

Davidson 10/14

ESBL PROJECT MANAGER / DATE

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

Tod Granicher
Project Manager

Please Note:
Analysis results reported on a dry-weight basis.

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

TP 9/28/92

Engineering Science, Inc.	Client Project ID:	W.O. #4310	Sampled:	~~Aug~~ Sep 1, 1992
600 Bancroft Way	Sample Descript:	Soil	Received:	Sep 8, 1992
Berkeley, CA 94710	Analysis for:	Total Kjeldahl Nitrogen	Analyzed:	Sep 16, 1992
Attention: Tom Paulson	First Sample #:	209-0841	Reported:	Sep 22, 1992

LABORATORY ANALYSIS FOR: Total Kjeldahl Nitrogen

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
209-0841	R2-V-7'-3"	20	37
209-0842	R2-A-5'-5.5'	20	31
209-0843	R2-A-3'-3.5'	20	70
-	Method Blank	20	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

Tod Granicher
Project Manager

Please Note:
Analysis results reported on a dry-weight basis.

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.
600 Bancroft Way
Berkeley, CA 94710
Attention: Tom Paulson

Client Project ID: W.O. #4310

QC Sample Group: 209-0841-43

Revised: Sep 28, 1992

QUALITY CONTROL DATA REPORT

ANALYTE	Total Phosphorous	Total Kjeldahl Nitrogen
Method:	EPA365.3	EPA351.4
Analyst:	K. Follett	G. Kern
Reporting Units:	mg/kg	mg/kg
Date Analyzed:	Jul 16, 1992	Sep 16, 1992
QC Sample #:	209-0841	209-0843
Sample Conc.:	43	70
Spike Conc. Added:	110	4300
Conc. Matrix Spike:	130	3900
Matrix Spike % Recovery:	79	89
Conc. Matrix Spike Dup.:	140	4100
Matrix Spike Duplicate % Recovery:	88	94
Relative % Difference:	7.4	5.0

SEQUOIA ANALYTICAL

Tod Granicher
Project Manager

% Recovery:	$\frac{\text{Conc. of M.S. - Conc. of Sample}}{\text{Spike Conc. Added}}$	x 100
Relative % Difference:	$\frac{\text{Conc. of M.S. - Conc. of M.S.D.}}{\text{(Conc. of M.S. + Conc. of M.S.D.) / 2}}$	x 100

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.	Client Project ID:	W.O. #4310	Sampled:	Aug 1, 1992
600 Bancroft Way	Sample Descript:	Soil, R2-V-7'-3"	Received:	Sep 8, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed:	Sep 15, 1992
Attention: Tom Paulson	Lab Number:	209-0841	Reported:	Sep 22, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	211.94g
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	2.99g
(C) % PASSING NO. 10 SIEVE:	98.59%

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½in.	0.0	0.0	0.0	100
3/8in.	0.0	0.0	0.0	100
No. 4	0.35	0.17	0.17	99.83
No. 10	2.64	1.25	1.42	98.58
PAN	0.0			
TOTAL	2.99			

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	21	21	17	13.5	0.035	26
5	21	20	16	13.7	0.022	24
10	21	19	15	13.8	0.016	23
15	21	18	14	14.0	0.013	21
25	21	18	14	14.0	0.010	21
40	21	17	13	14.2	0.0080	20
60	21	17	13	14.2	0.0066	20
90	21	16	12	14.3	0.0054	18
120	21	15	11	14.5	0.0047	17
1440	21	12	8	15.0	0.0014	12

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65g
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.994
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01348

FORMULAS:
R = H - E - F
S = K [SQRT (L / T)]
P = (R / W) 100
W = (J · 100) / C
J = D · G

SEQUOIA ANALYTICAL

Tod Granicher
Project Manager

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.	Client Project ID:	W.O. #4310	Sampled:	Aug 1, 1992
600 Bancroft Way	Sample Descript:	Soil, R2-A-5'-5.5'	Received:	Sep 8, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed:	Sep 15, 1992
Attention: Tom Paulson	Lab Number:	209-0842	Reported:	Sep 22, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	222.32g
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	4.03g
(C) % PASSING NO. 10 SIEVE:	98.19%

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½in.	0.0	0.0	0.0	100
3/8in.	0.0	0.0	0.0	100
No. 4	0.18	0.08	0.08	99.92
No. 10	3.85	1.73	1.81	98.19
PAN	0.0			
TOTAL	4.03			

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	20	28	24	12.4	0.034	37
5	20	27	23	12.5	0.022	35
10	20	26	22	12.7	0.015	34
15	20	25	21	12.9	0.013	32
25	20	25	21	12.9	0.010	32
40	20	24	20	13.0	0.0078	30
60	20	24	20	13.0	0.0064	30
90	20	24	20	13.0	0.0052	30
120	20	23	19	13.2	0.0045	29
1440	20	20	16	13.7	0.0013	24

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65g
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.992
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01365

FORMULAS:

$R = H - E - F$

$S = K [SQRT (L / T)]$

$P = (R / W) 100$

$W = (J \cdot 100) / C$

$J = D \cdot G$

SEQUOIA ANALYTICAL

Tod Granicher
Project Manager

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.	Client Project ID:	W.O. #4310	Sampled:	Aug 1, 1992
600 Bancroft Way	Sample Descript:	Soil, R2-A-3'-3.5'	Received:	Sep 8, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed:	Sep 15, 1992
Attention: Tom Paulson	Lab Number:	209-0843	Reported:	Sep 21, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	205.99g
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	19.88g
(C) % PASSING NO. 10 SIEVE:	90.35%

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½in.	0.0	0.0	0.0	100
3/8in.	2.80	1.36	1.36	98.64
No. 4	4.91	2.38	3.74	96.26
No. 10	12.17	5.91	9.65	90.35
PAN	0.0			
TOTAL	19.88			

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	20	24	20	13.0	0.035	28
5	20	23	19	13.2	0.022	27
10	20	22	18	13.3	0.016	25
15	20	22	18	13.3	0.013	25
25	20	22	18	13.3	0.010	25
40	20	21	17	13.5	0.0079	24
60	20	20	16	13.7	0.0065	22
90	20	20	16	13.7	0.0053	22
120	20	19	15	13.8	0.0046	21
1440	20	18	14	14.0	0.0013	20

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65g
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.990
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01365

FORMULAS:

$R = H - E - F$

$S = K [SQRT (L / T)]$

$P = (R / W) 100$

$W = (J \cdot 100) / C$

$J = D \cdot G$

SEQUOIA ANALYTICAL

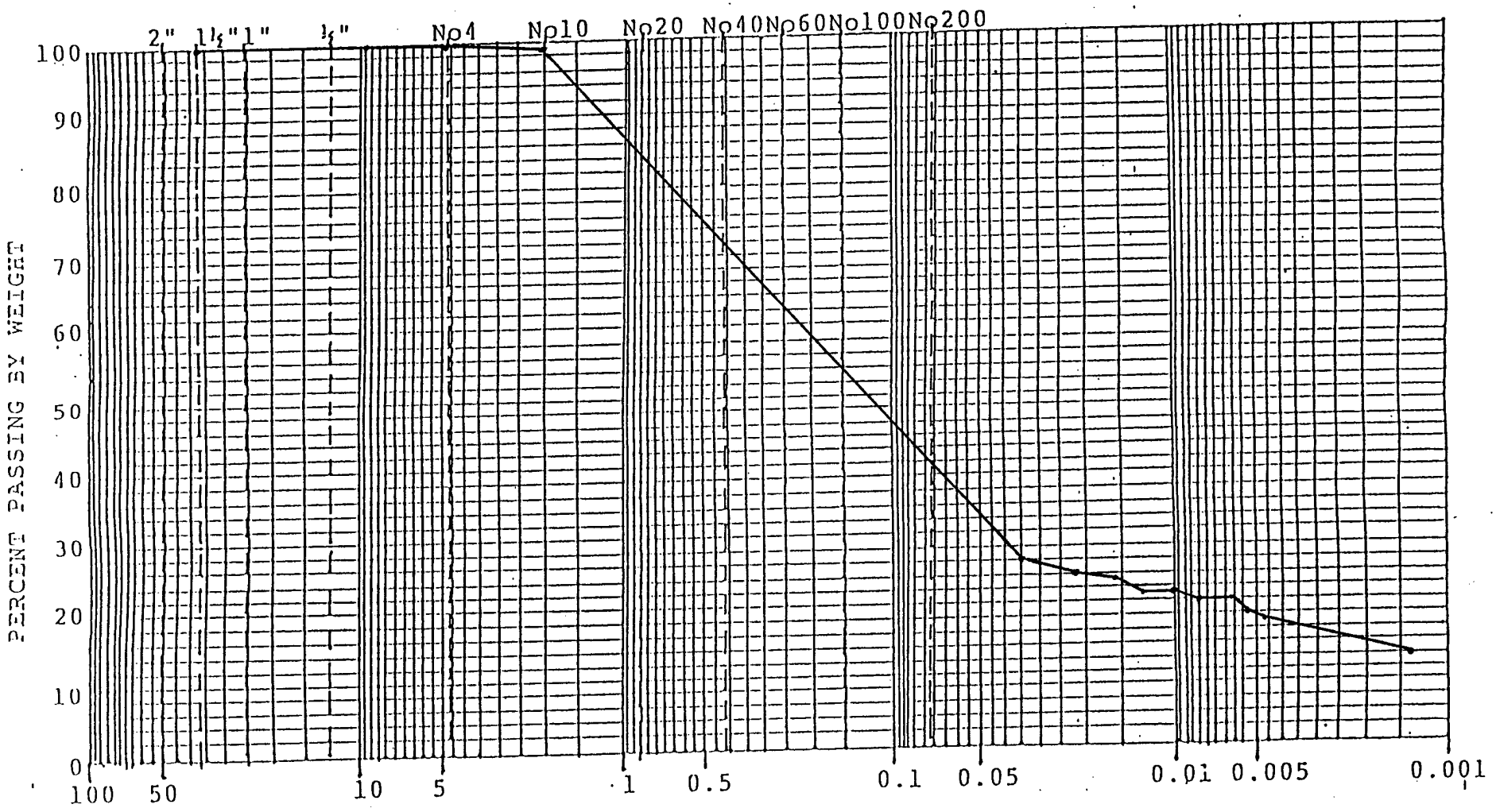
Tod Granicher
Project Manager

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 209-0841

GRAVEL	0%
SAND	61%
SILT	25%
CLAY	14%

U.S. STANDARD SIEVE SIZES



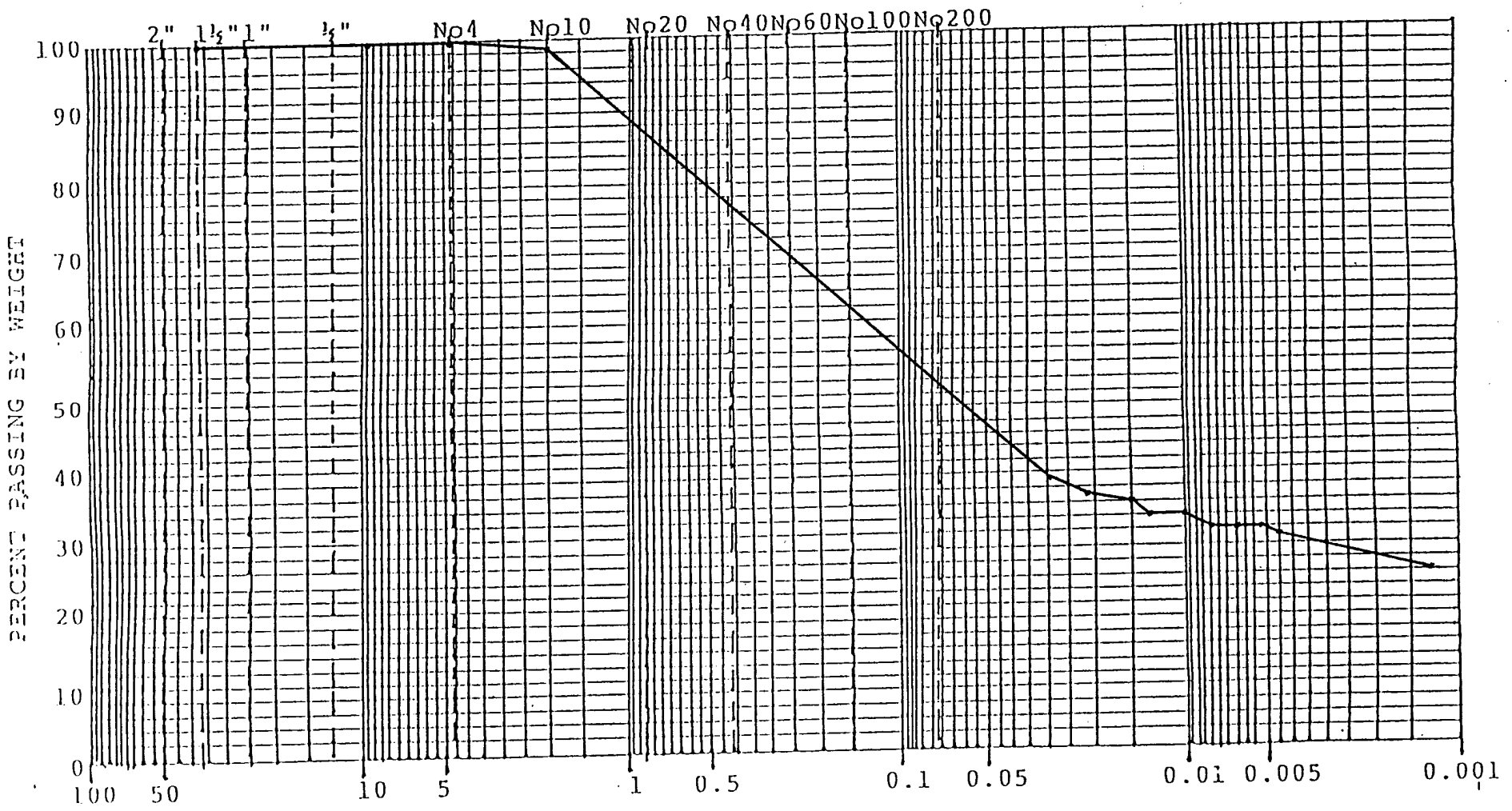
COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES
	GRAVEL		SAND			FINES	

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 209-0842

GRAVEL	[illegible]
SAND	49%
SILT	25%
CLAY	26%

U.S. STANDARD SIEVE SIZES



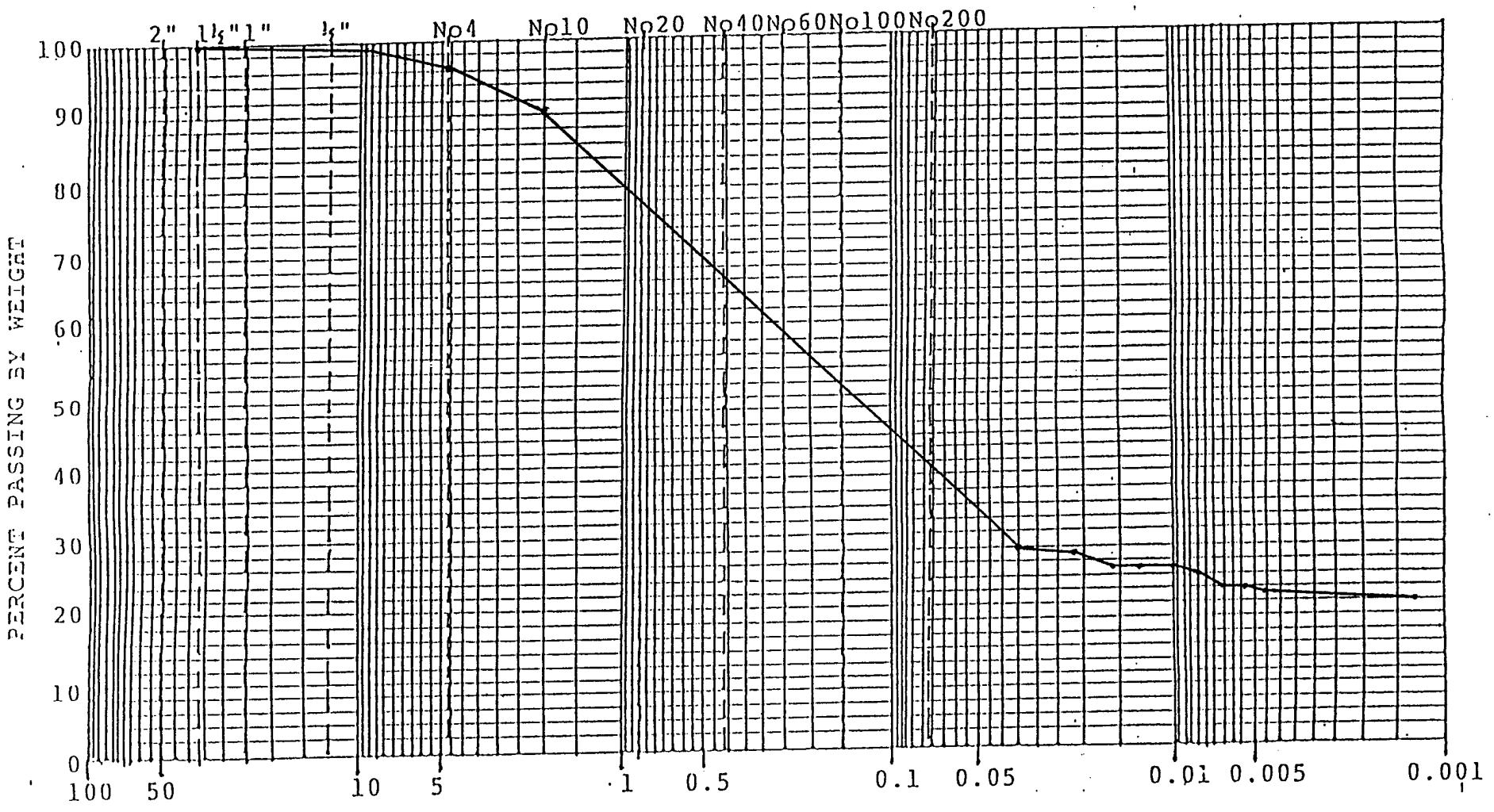
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES
OBBLES	GRAVEL		SAND			FINES	

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 209-0843

GRAVEL	
SAND	57%
SILT	19%
CLAY	20%

U.S. STANDARD SIEVE SIZES



C-OF-C NUMBER _____ OF _____

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD

ES JOB NO.	PROJECT NAME/LOCATION
	4310

FIELD CONTACT:

SAMPLERS NAMES & SIGNATURES

ESTELITO DELOS TRINOS

PRESERVATIVES REQUIRED

ANALYSES REQUIRED

DATE	TIME	FIELD SAMPLE IDENTIFIER	TKN	Total Phosphorous as PHOSPHATE Method 365.3	ASTM D422 Sieve + hydrom										REMARKS
~~8/1/92~~ 9/28/92	1300	R-2-V-7'3" (4310.01C)	✓	✓	✓				20108	41					TKN 351.2
~~8/1/92~~	1500	R2-A-5-5.5' (4310.02C)	✓	✓	✓				↓	42					Phosphorus 365.3
~~8/1/92~~	1445	R2-A-3-3.5' (4310.03C)	✓	✓	✓					43					2 wk TAT
															Report to: Tom Paulson ESBL
															Report results on dry soil basis

TP 9/28/92 7/1/92

SHIP TO:

FIELD CUSTODY RELINQUISHED BY: _____ DATE: 9 18 92 TIME: 1175

SHIPPED VIA: _____ AIRBILL # _____ ON RECEIPT: CUSTODY SEALS? _____ ; TEMP: _____ °C

RECEIVED FOR LABORATORY BY: _____ DATE: 9 18 92 TIME: 11:25 AM

RELINQUISHED [redacted] 9/18/92 1:10 read by K ENGNEER 9-8-92 1:10 PM

Battelle
Columbus Laboratories

Robin AFB GA

Form No. _____

CHAIN OF CUSTODY RECORD

Proj. No.	Project Title
DE268.03	RAFB / Battelle

SAMPLERS: (Signature) Amanda J Bush

DATE	TIME	SAMPLE I.D.	BTEX/TPH	pH	alkalinity	IRON	TOTAL SOIL MOISTURE	TOTAL KJELDAHL NITROGEN	TOTAL Phosphate	# Sieve only	Container No.	Number of Containers	Remarks
01 Sept 92	1300	R2-V-7'3"	✓								1	1	Brass Sleeve
01 Sept 92	1300	R2-V-7'3"		✓	✓	✓	✓				1	1	4oz Glass
01 Sept 92	1300	R2-V-7'3"					✓	✓	✓		1	1	16oz Glass
01 Sept 92	1500	R2-A-5-5.5'	✓								1	1	Brass Sleeve
01 Sept 92	1500	R2-A-5-5.5'		✓	✓	✓	✓				1	1	4oz glass
01 Sept 92	1500	R2-A-5-5.5'					✓	✓	✓		1	1	16oz Glass
01 Sept 92	1445	R2-A-3-3.5'	✓								1	1	Brass Sleeve
01 Sept 92	1445	R2-A-3-3.5'		✓	✓	✓	✓				1	1	4oz glass
01 Sept 92	1445	R2-A-3-3.5'					✓	✓	✓		1	1	16oz glass

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Amanda J Bush	9-3-92 1310				
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	
			09/04/92 0850		

Page _____ of _____

APPENDIX B

SITE SS10 SOIL GAS PERMEABILITY DATA

TABLE B-1. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT R2-MPA							
Time (min)	Pressure (psi) at Depth (feet)			Time (min)	Pressure (psi) at Depth (feet)		
	6′	4.5′	3′		6′	4.5′	3′
0	0.005	0.005	0	18	18.0	17.9	0.015
1	17.5	17	0.015	21	18.1	18.0	0.015
2	17.6	17.5	0.015	24	18.0	17.9	0.015
3	17.7	17.8	0.015	27	18.1	17.9	0.015
4	18	17.9	0.015	30	18.2	17.9	0.015
5	18.5	17.9	0.015	35	18.2	17.9	0.015
6	18.5	17.5	0.015	40	18.2	17.9	0.015
7	18.5	17.5	0.015	45	18.2	18.0	0.015
8	18.0	17.5	0.15	55	18.2	18.1	0.015
9	17.9	17.6	0.010	65	18.3	18.0	0.015
10	17.9	17.6	0.010	75	18.5	18.0	0.015
11	17.9	17.5	0.010	95	18.5	18.0	0.015
12	17.9	17.5	0.010	115	18.5	18.0	0.015
15	17.9	17.5	0.010	135	18.5	18.0	0.015

TABLE B-2. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT R2-MPB							
Time (min)	Pressure (psi) at Depth (feet)			Time (min)	Pressure (psi) at Depth (feet)		
	3′	4′5″	9′		3′	4′5″	9′
0	0	0.015	0.02	15	0.05	6.0	6.5
1	0.02	3.7	4.5	17	0.054	6.0	6.5
2	—	—	—	20	0.054	6.0	6.5
3	0.042	5.6	6.2	25	0.066	6.4	6.6
4	—	—	—	30	0.055	6.3	6.7
5	0.047	6.0	6.4	40	0.055	6.4	6.9
6	—	—	—	50	0.06	6.5	7.0
7	0.052	6.0	6.4	60	0.057	6.6	7.2
8	—	—	—	80	0.049	6.7	7.4
9	0.050	5.9	6.3	100	0.047	6.8	7.5
10	—	—	—	120	0.044	7.0	7.6
11	0.05	5.9	6.3	140	0.047	7.0	7.7
13	0.05	6.0	6.4				

TABLE B-3. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT R2-MPC							
Time (min)	Pressure (psi) at Depth (feet)			Time (min)	Pressure (psi) at Depth (feet)		
	3′	4′5″	6′		3′	4′5″	6′
0	0	0	0	13	0	0.225	0.22
1	<0	0.02	0.04	15	0	0.27	0.245
2	—	—	—	17	0	0.29	0.270
3	0	0.03	0.06	20	0	0.37	0.32
4	—	—	—	25	0	0.23	0.27
5	0	0.1	0.125	30	0	0.27	0.23
6	—	—	—	40	0	0.22	0.205
7	0	0.065	0.085	50	0	0.27	0.25
8	—	—	—	60	0	0.23	0.22
9	0.02	0.045	0.07	80	0	0.23	0.222
10	—	—	—	100	0	0.235	0.215
11	0	0.205	0.19				

APPENDIX C

SITE SS10 IN SITU RESPIRATION TEST DATA

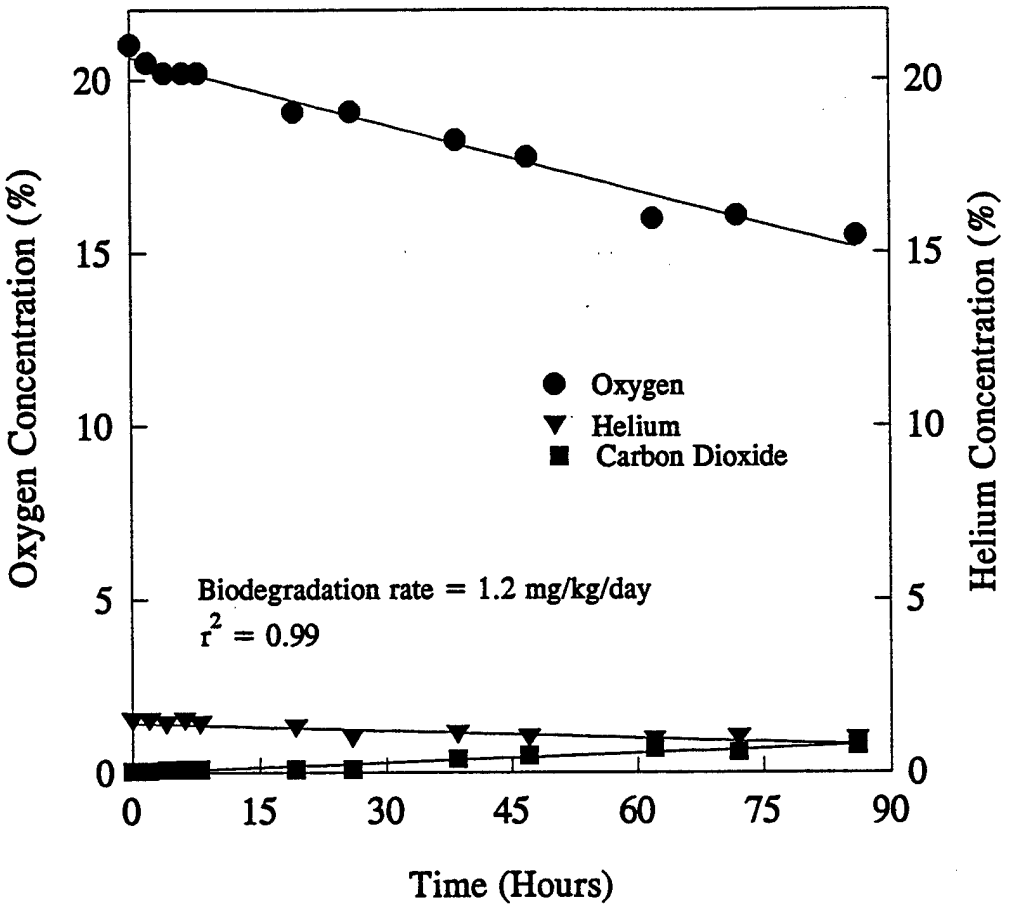


Figure C-1. Oxygen Utilization During In Situ Respiration Test at Monitoring Point R2-MPA-4'6"

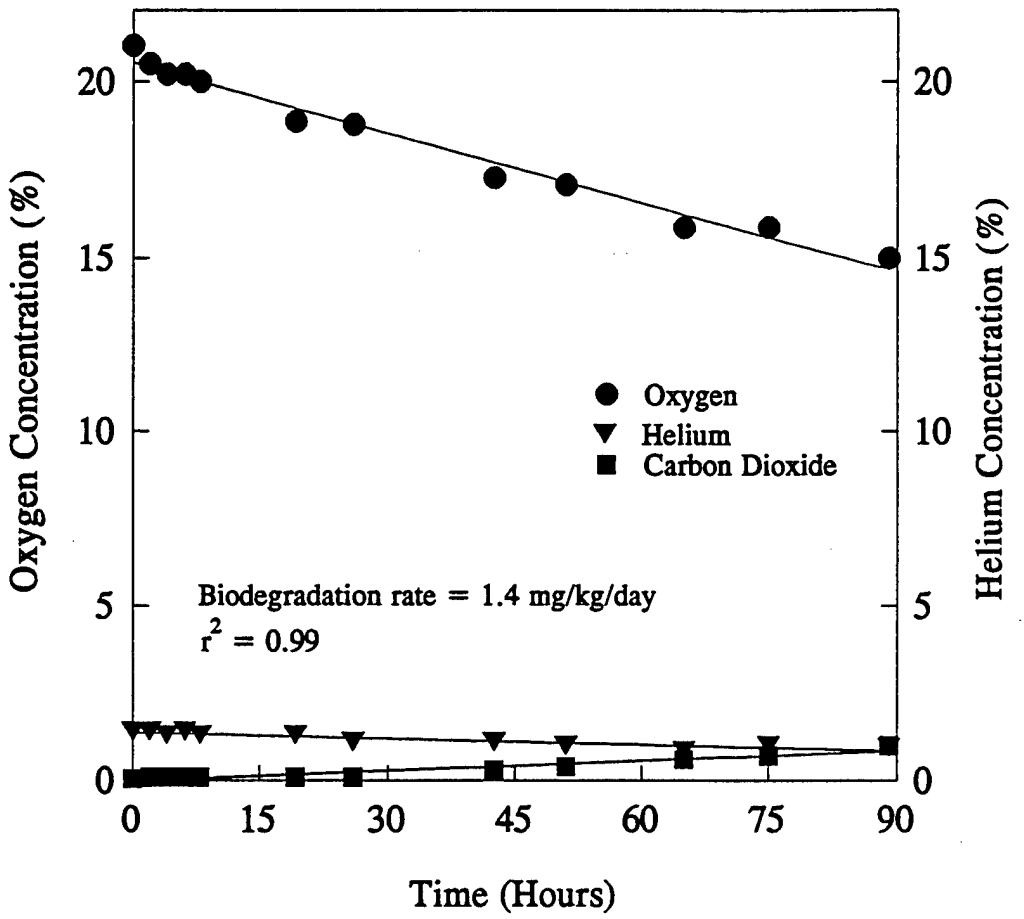


Figure C-2. Oxygen Utilization During In Situ Respiration Test at Monitoring Point R2-MPA-6'

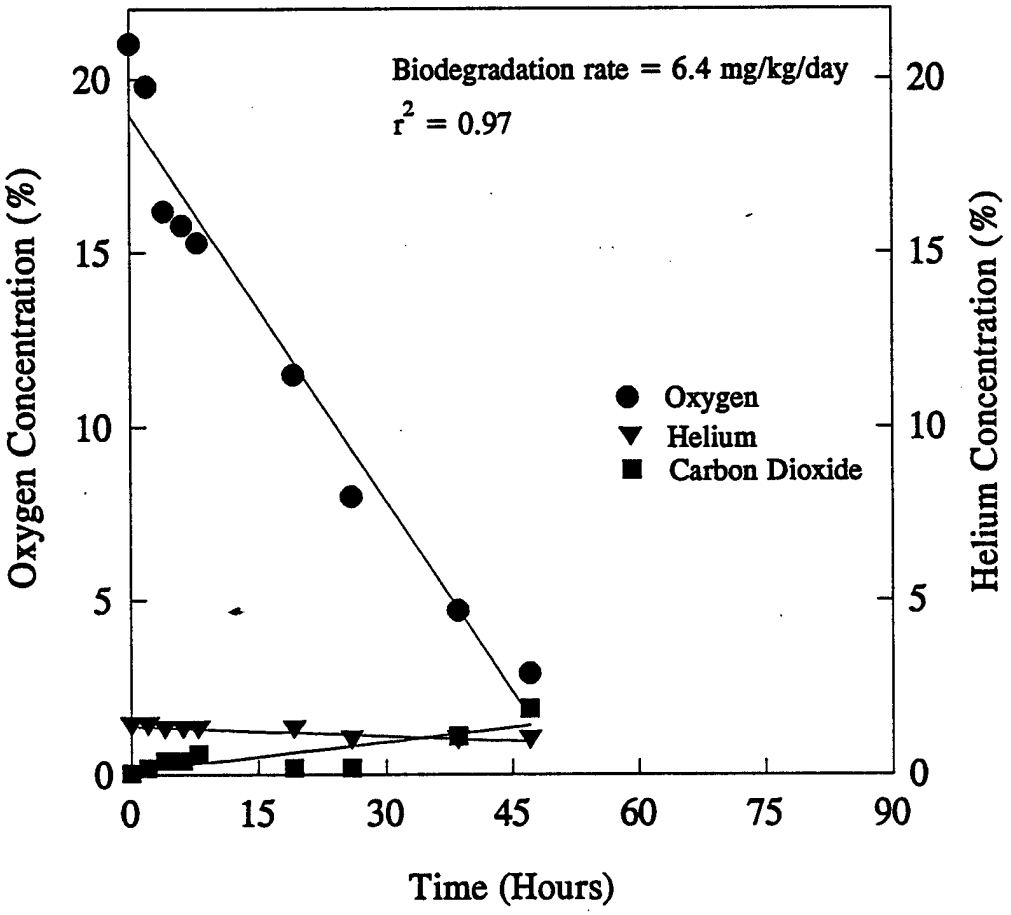


Figure C-3. Oxygen Utilization During In Situ Respiration Test at Monitoring Point R2-MPC-4'6"

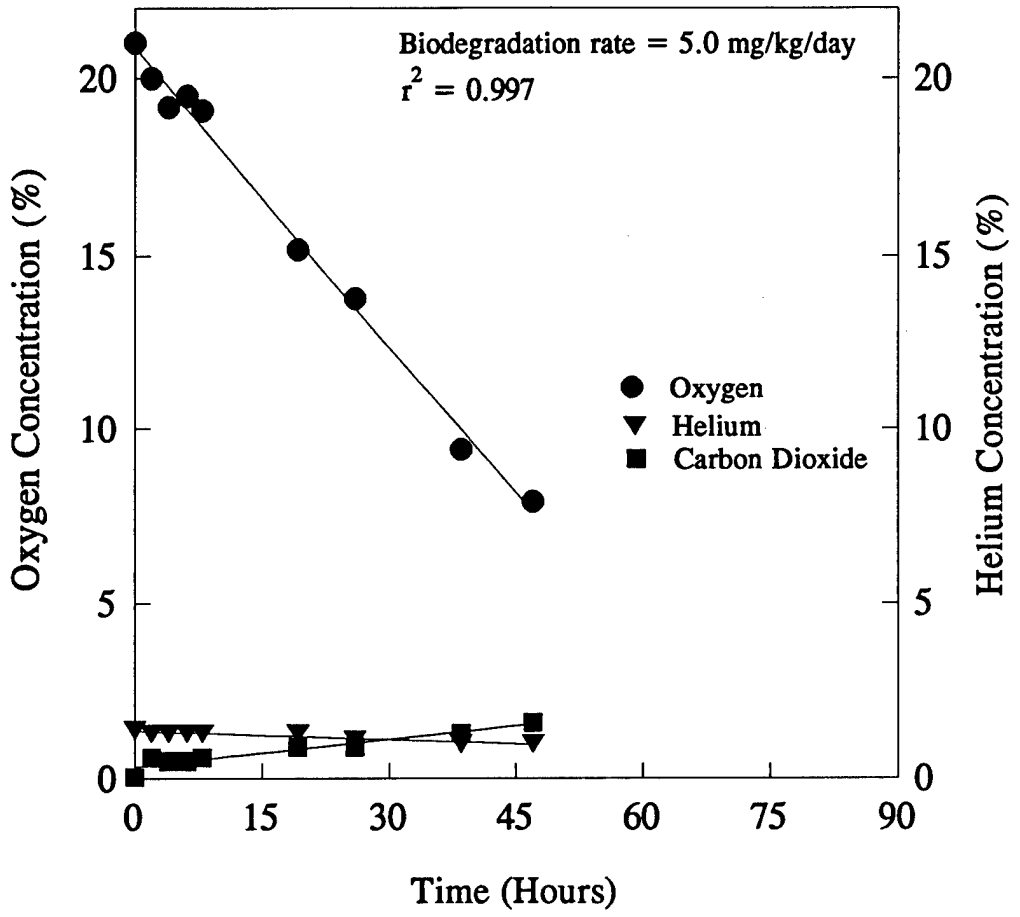


Figure C-4. Oxygen Utilization During In Situ Respiration Test at Monitoring Point R2-MPC-6'